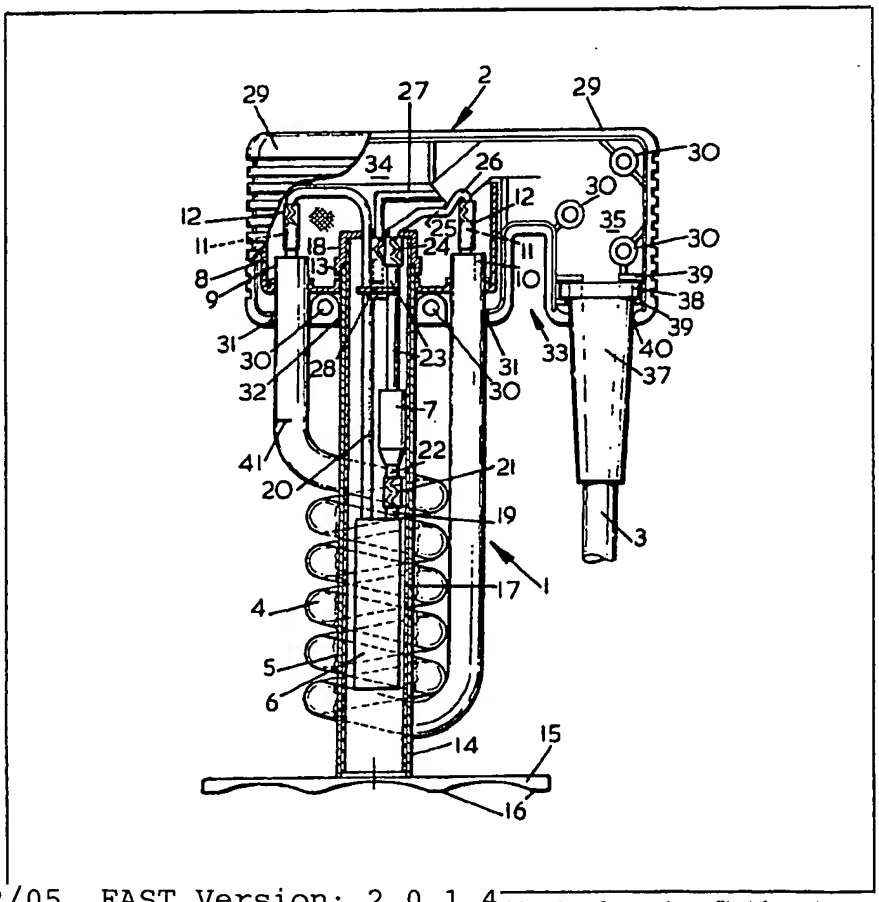
(12) UK Patent Application (19) GB (11) 2 086 698 A

(21) Application No 8034034
(22) Date of filing
22 Oct 1980
(43) Application published
12 May 1982
(51) INT CL³ H05B 3/80
(52) Domestic classification
H5H 111 130 194 211 213 224 231 232 234 243 256 274 275 AH
(56) Documents cited
GB 1592965
GB 790901
GB 708923
GB 699915
GB 620384
GB 601843
(58) Field of search
H5H

(71) Applicant
Pifco Limited
Failsworth
Manchester M35 0HS
(72) Inventor
P Robinson
(74) Agents
Marks & Clerk
Scottish Life House
Bridge Street
Manchester M3 3DP

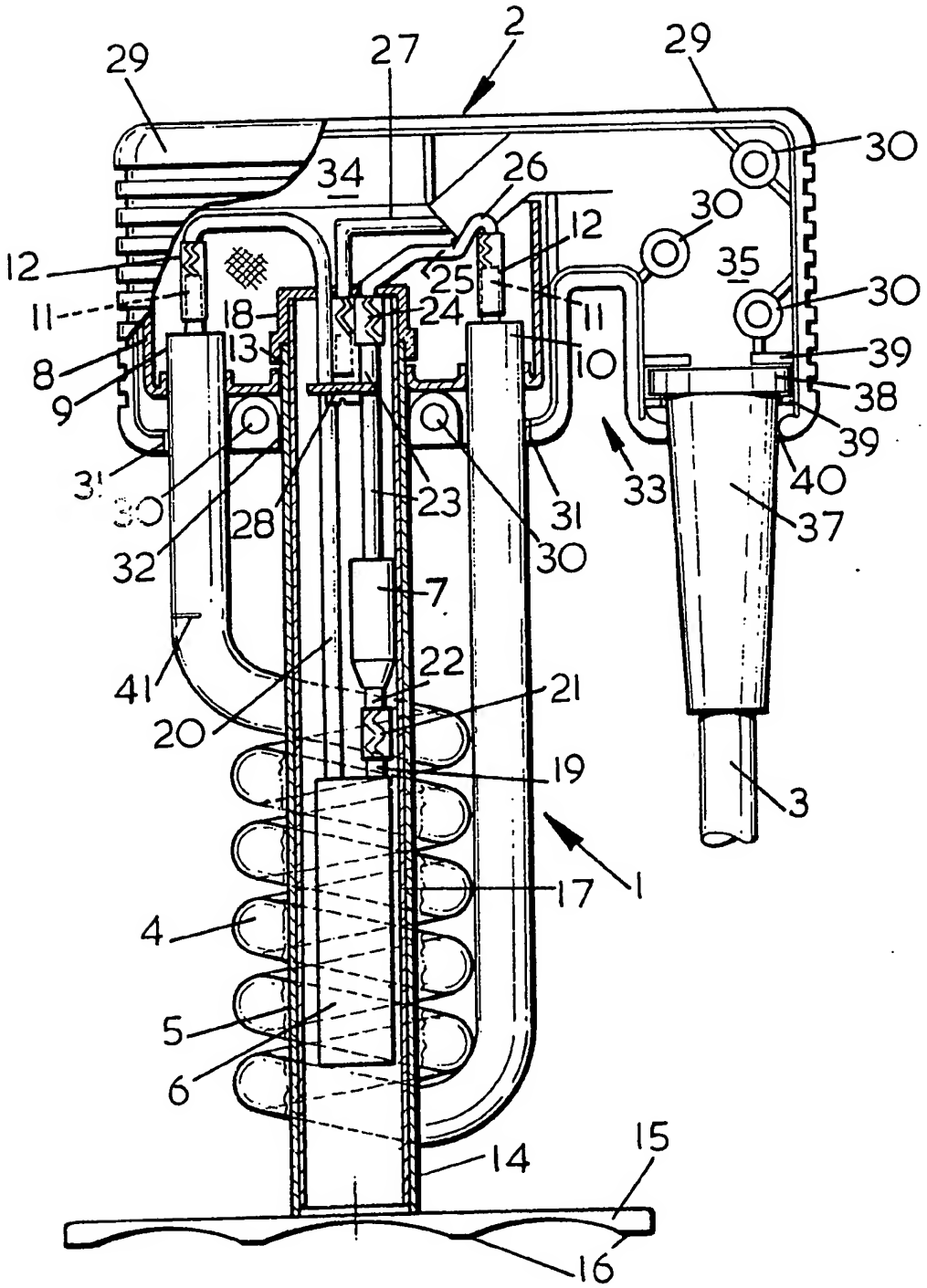
(54) An immersion heater

(57) A portable electric immersion heater for heating a liquid held within a container comprises a coiled electrical heating element located within tube (4) for immersion in the liquid, a head arrangement (2) to which the element is connected and which comprises means (33) whereby the heater may be located on a rim of the container to permit the element to be suspended in the liquid, and heat sensitive means (6) connected into an electrical supply circuit for the heating element and located within the coils of the heating element whereby, in use when the ambient temperature around the heat sensitive means reaches a first upper predetermined level, the means operate to break said supply circuit, and when the ambient temperature then falls below the predetermined level, the device 6 then operates to close the circuit once more. Should the thermostat 6 fail to operate, excessive over heating will fuse heat sensitive device 7, disabling the heater until this device is replaced.



GB 2 086 698 A

2086698


2
27
29
29
34
26
30
30
12
12
25
35
30
11
18
24
11
39
13
10
8
9
38
39
40
31
30
28
23
31
33
37
32
30
7
41
22
21
20
19
3
1
17
4
5
6
14
15
16

SPECIFICATION

An immersion heater

The present invention relates to a portable electric immersion heater for use particularly for boiling water contained within a large cup, beaker or similar container, the immersion heater being attachable to the rim of the container.

According to the present invention there is provided a portable electric immersion heater for heating a liquid held within a container and comprising a coiled electrical heating element for immersion in the liquid, a head arrangement to which the element is connected and which comprises means whereby the heater may be located on a rim of the container to permit the element to be suspended in the liquid, and heat sensitive means connected into an electrical supply circuit for the heating element and located within the coils of the heating element whereby, in use when the ambient temperature around the heat sensitive means reaches a first upper predetermined level, the means operate to break said supply circuit and to cut off the electric current supply to the heating element.

Preferably, the heat sensitive means are adapted, in use, to close said supply circuit when the ambient temperature around the heat sensitive means falls below said first upper predetermined level.

Preferably also, a heat sensitive electrical cut out is provided connected into said supply circuit whereby when the ambient temperature around the cut out reaches a second upper predetermined level, which is higher than said first upper level, the cut out operates to break irreversibly said supply circuit.

Preferably also, the heat sensitive means and the cut out are located within a tube which is connected to the head arrangement and which is located within a coiled tube housing the coils of the heating element and along the longitudinal axis of said coiled tube.

Preferably also, the tube is attached to a disc of greater diameter than the width of the coiled tube, which disc acts a guard to prevent contact between the coiled tube and an adjacent surface of the container.

The present invention will now be described by way of example with reference to the accompanying drawing which shows, in partial cross section, an elevation of a portable immersion heater.

The portable immersion heater comprises an electrical element arrangement 1 connected to a head arrangement 2, which enables the heater to be attached to the rim of a container and the element arrangement 1 to be connected to an electricity supply *via* a cable 3.

The element arrangement 1 comprises a coiled first tube 4, in which is located an electrical heating element (not shown), and a cylindrical second tube 5 housing heat sensitive electrical devices 6 and 7 as is described below. The first and second tubes 4 and 5 are attached to a metallic container 8 located within the head arrangement 2.

The first tube 4 is metallic and tightly coiled in a helical fashion. The ends 9 and 10 of the tube 4 are arranged so that they are parallel and are force fitted through apertures formed in the base of the container 8 so as to project upwardly in the container 8. The tube 4 houses an electrical heating element (not shown), which is electrically insulated and arranged along the total length of the tube 4. The ends of the element are provided with spigot connectors 11 over which complementary connectors 12 forming part of the electrical supply circuitry are push fitted.

The second tube 5 is also metallic and is located within the coils of the first tube 4 so that it lies along the longitudinal axis of the helix formed by said tube 4. One end 13 of the tube 5 is open and is force fitted through a further aperture formed in the base of the container 8 so as to project upwardly in the container 8 in a similar fashion to the ends 9 and 10 of the tube 4. The other end 14 of the tube 5 is closed and attached to a disc 15 which forms a guard for the tube 4. The disc 15 has a diameter which is greater than that of the overall width of the helical arrangement of the tube 4. In this way, when the immersion heater is located within a container, the disc 15 prevents the tube 4, which becomes hot in use, from coming into contact with the sides or base of the container. Additionally, if the immersion heater is placed on a horizontal surface, the disc 15 acts as a foot on which the immersion heater can stand or otherwise prevents the tube 4 from contacting said surface. To create an insulating air gap between the lower surface of the disc 15 and said surface when the disc 15 is in use as a foot, two annular ridges 16 are formed on the lower surface of the disc 15.

Located within the tube 5 are the two heat sensitive electrical devices 6 and 7 which are connected in series with one another and the electrical heating element. As a safety precaution, the tube 5 is lined with an electrically insulating lining tube 17 which sheaths the devices 6 and 7 and their electrical lead wires. In addition, the tube 17 is also filled with magnesium oxide powder (not shown) and projects upwardly into the container 8, the projecting open end being closed by an insulating cap 18, which also covers the end of the tube 5.

The device 6 comprises heat sensitive means which are self resetting whereby the ambient temperature rises above an upper predetermined temperature the means operate electrical circuit and when the

ambient temperature then falls below the predetermined temperature the means operate to close the circuit once again. The device 7 comprises a heat sensitive electrical cut out which includes a fusible element that melts at a predetermined temperature which is arranged to be above that of the upper predetermined temperature of the device 6. Provided that the device 7 is kept below its predetermined temperature it remains electrically conducting. However, once the predetermined temperature is reached, the fusible element melts and the device becomes irreversibly incapable of conducting electricity so that it thereafter constitutes a permanent break in the electrical supply circuit to the heating element until replaced.

The device 6 is provided with two electrical lead wires 19 and 20. The wire 19 is crimped as at 21 to one wire 22 of a pair of lead wires 22, 23 of the device 7 whereas the other wire 20 of the device 6 passes out of the tubes 5 and 17 through an aperture formed in the cap 18 and is crimped to one of the connectors 12 which is push fitted over one of the spigot connectors 11 of the electrical heating element. The other lead wire 23 of the device 7 is crimped as at 24 to a live wire 25 of the cable 3 which passes into the tubes 5 and 17 *via* an aperture in the cap 18. A neutral wire 26 of the cable 3 is crimped to the other connector 12 which is fitted over the other spigot connector 11 of the electrical heating element and an earth wire 27 of the cable 3 is similarly attached to an earth connector 28 which is in electrical contact with the container 8 adjacent the aperture through which the tube projects.

It can be seen that all the electrical connections of the lead wires 25, 26 and 27 of the cable 3 to the other elements of the circuit occur either within the container 8 or within the tube 5. As a safety precaution and to prevent tampering, the container 8 is filled with a plastics material (not shown) which encapsulates all the connections and closes off entry to the tubes 4 and 5.

As is described above, the container 8 is located within the head arrangement 2 of the immersion heater, which arrangement comprises, apart from the container 8, a plastics cover 29 including means for the attachment of the cable 3 thereto and means enabling the immersion heater to be located on the rim of a container or vessel containing liquid to be heated so that the tubes 4 and 5 can be dipped into the liquid. The cover 29 is made in two parts which can be permanently snap fitted together by a plurality of fastening means 30. The cover 29 is provided with apertures 31 and 32 for the tubes 4 and 5 and is closed around the container 8 to encase same and to leave the tubes 4 and 5 protruding therefrom. The means enabling the attachment of the head to the rim of a vessel comprise a groove or slot 33 which is formed in the cover 29 between a region 34 thereof in which the container 8 is located and a region 35 wherein the cable 3 is fastened. The slot 33 enables the cover 29 to be located and balance over the rim of the vessel thereby to support the immersion heater within the vessel.

The cable 3 is attached at one end to the immersion heater and has its other end attached to means such as a plug enabling the immersion heater to be connected to an electricity supply. The lead wires 25, 26 and 27 of the cable 3 are attached to the heating element and devices 6 and 7 as described above and the adjacent length of cable 36 located within the cover 29 is passed through a labyrinth formed in the region 35 by several of the fastening means 30 which project inwardly within the cover 29 before egressing from the cover 29 *via* a sheath 37. The sheath 37 comprises a moulded plastics member which has an annular flange 38 integral therewith, which flange 38 is located between two adjacent annular flanges 39 formed within the cover adjacent an aperture 40 through which the cable 3 exits from the cover 29. The sheath 37 and the labyrinth arrangement are provided to prevent the cable 3 from being manually pulled out of the head arrangement 2.

In use, the immersion heater is located on the rim of a vessel or container containing liquid to be heated by means of the slot 33 so that the tubes 4 and 5 are immersed within the liquid to a maximum level as indicated by a marker 41 on the tube 4. When the cable 3 is connected to an electricity supply, the heating element is supplied with current and heats the tube 4 which in turn heats the liquid. If the immersion heater is designed to boil water, then the resetting heat sensitive means 6 is set so that its upper predetermined temperature is approximately or just above 100°C. Hence, if the ambient temperature around and within the tube 5 reaches this temperature then the means 6 will operate to cut off the current supply to the heating element. Likewise, if the ambient temperature around the means 6 then drops below this temperature then the means 6 will operate to restore the current supply. Hence, the immersion heater can be used to heat liquid to a predetermined temperature and retain the liquid substantially at this temperature. The means 6 operating to cut off the current supply to the heater if the liquid being heated boils dry or if the heater is removed from the liquid.

The second heat sensitive device 7 is designed to come into operation only if the means 6 fails so that current can still flow to the heating element. In this case, if the ambient temperature around and within the tube 5 raises substantially above the predetermined

this may occur if a liquid being heated boils dry or the immersion heater is removed from the liquid without being disconnected from the electricity supply. When this second upper predetermined temperature is reached, the cut out device 7 operates and permanently breaks the circuit within the immersion heater. Once this has happened, the immersion heater can no longer be used until the device 7 is replaced, which effectively makes the heater useless. Hence, the device 7 is provided for safety and only operates in extreme circumstances. To prevent the device 7 from becoming unnecessarily hot during normal operation of the immersion heater, it can be seen that the device 7 is located within the tube 5 above the upper level of coils at approximately the maximum recommended level of immersion for the tube 5 as indicated by the marker 41.

The advantages of the immersion heater of the present invention over conventional heaters of this type is the location of the resetting heat sensitive means 6 within the coils of the heating element as opposed to in the head arrangement 2. This gives greater sensitivity as it takes less time for the means 6 to respond to changes in temperature of the liquid and consequently ensures that the liquid is kept substantially at the desired temperature and that electricity is not wasted by having current supplied to the heating element unnecessarily.

CLAIMS

1. A portable electric immersion heater for heating a liquid held within a container and comprising a coiled electrical heating element for immersion in the liquid, a head arrangement to which the element is connected and which comprises means whereby the heater may be located on a rim of the container to permit the element to be suspended in the liquid, and heat sensitive means connected into an electrical supply circuit for the heating element and located within the coils of the heating element whereby, in use when the ambient temperature around the heat sensitive means reaches a first upper predetermined level, the means operate to break said supply circuit and to cut off the electric current supply to the heating element.

2. A portable electric immersion heater according to claim 1, wherein the heat sensitive means are adapted, in use, to close said supply circuit when the ambient temperature around the heat sensitive means falls below said first upper predetermined level.

3. A portable electric immersion heater according to claim 1 or 2, wherein a heat sensitive electrical cut out is provided connected into said supply circuit whereby when the ambient temperature around the cut reaches a second upper predetermined level, the cut out operates to break irreversibly said supply circuit.

4. A portable electric immersion heater according to claim 3, wherein the heat sensitive means and the cut out are located within a tube which is connected to the head arrangement and which is located within a coiled tube housing the coils of the heating element and along the longitudinal axis of said coiled tube.

5. A portable electric immersion heater according to claim 4, wherein the tube is attached to a disc of greater diameter than the width of the coiled tube, which disc acts as a guard to prevent contact between the coiled tube and an adjacent surface of the container.

6. A portable electric immersion heater substantially as hereinbefore described with reference to the accompanying drawing.

Printed for Her Majesty's Stationery Office
by Burgess & Son (Abingdon) Ltd.—1982.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.

United States Patent [19]

Lefebvre

[11] **4,234,785**

[45] **Nov. 18, 1980**

[54] **LIQUID LEVEL RESPONSIVE CONTROL DEVICE**

[76] Inventor: **Fredrick L. Lefebvre**, 700 Solano Prado, Coral Gables, Fla. 33156

[21] Appl. No.: **7,154**

[22] Filed: **Jan. 26, 1979**

[51] Int. Cl.³ **H05B 3/06**

[52] U.S. Cl. **219/523**; 219/318; 219/324; 219/331; 219/333; 219/337; 219/354; 219/494; 219/541; 119/5; 250/354

[58] Field of Search ..... 219/216, 218, 326, 331, 219/324, 328, 333, 334, 335, 354, 336, 337, 437, 489, 494, 512, 517, 523, 541, 544, 553; 119/5; 337/120, 315; 200/84 R

[56] **References Cited**

U.S. PATENT DOCUMENTS

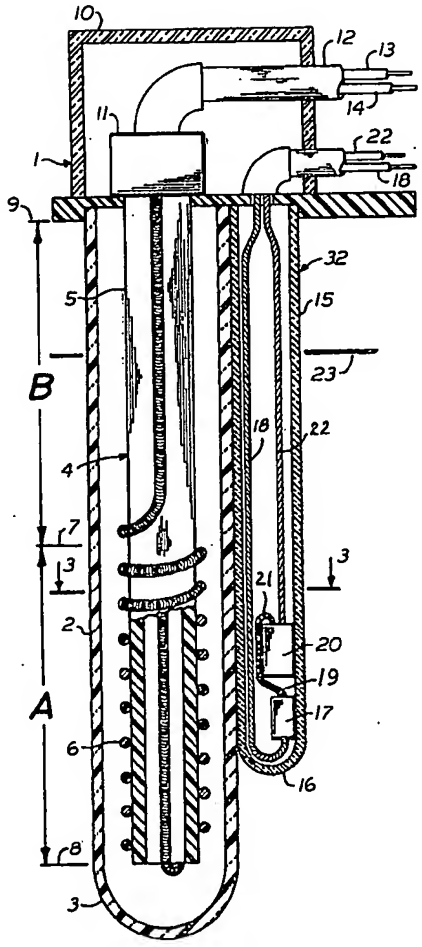
3,134,008	5/1964	Finn	219/523
3,576,426	4/1971	Sesholtz	219/523
3,619,565	11/1971	D'Elia	219/523
3,746,836	7/1971	Summerfield et al.	219/328
3,983,361	9/1976	Wild et al.	219/523 X
4,068,116	1/1978	McKinstry	219/337 X
4,107,514	8/1978	Ellson	219/523

Primary Examiner—Volodymyr Y. Mayewsky
Attorney, Agent, or Firm—Frank B. Robb

[57] **ABSTRACT**

There is disclosed liquid level responsive control means for use with heating means for liquid in tanks comprising a control unit, main power supply connections therefore, a source of radiant energy to be immersed in the liquid being heated, sensing instrumentalities closely adjacent said source, said instrumentalities including a recycling bi-metal switch operable at a predetermined temperature produced by the source aforesaid, and a non-recycling or fuse element connected in series with the said switch and operable at a higher temperature, connections from the control unit to supply power to the radiant energy source and connections to the sensing instrumentalities and to the tank heating means.

7 Claims, 5 Drawing Figures



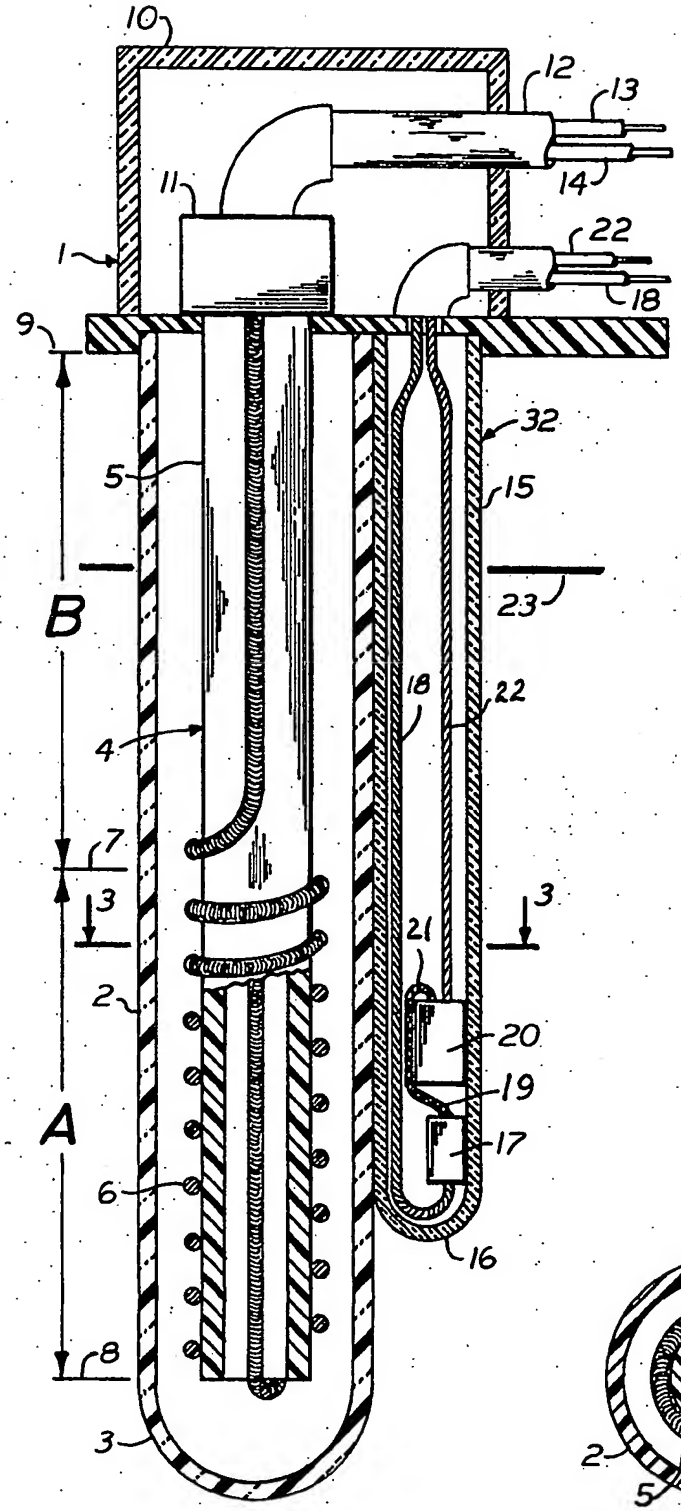


FIG. 1

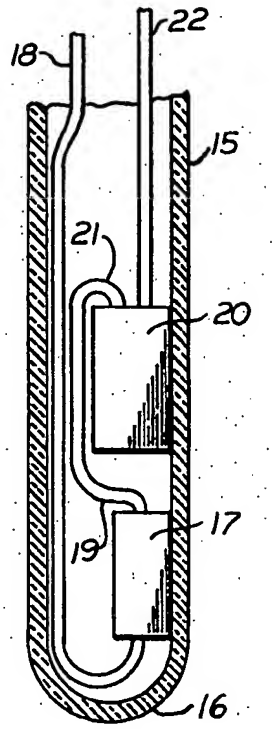


FIG. 2

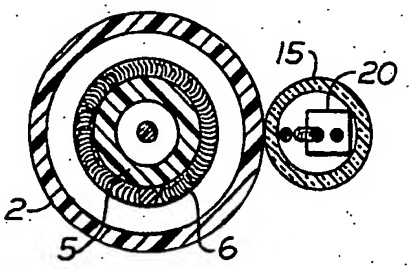


FIG. 3

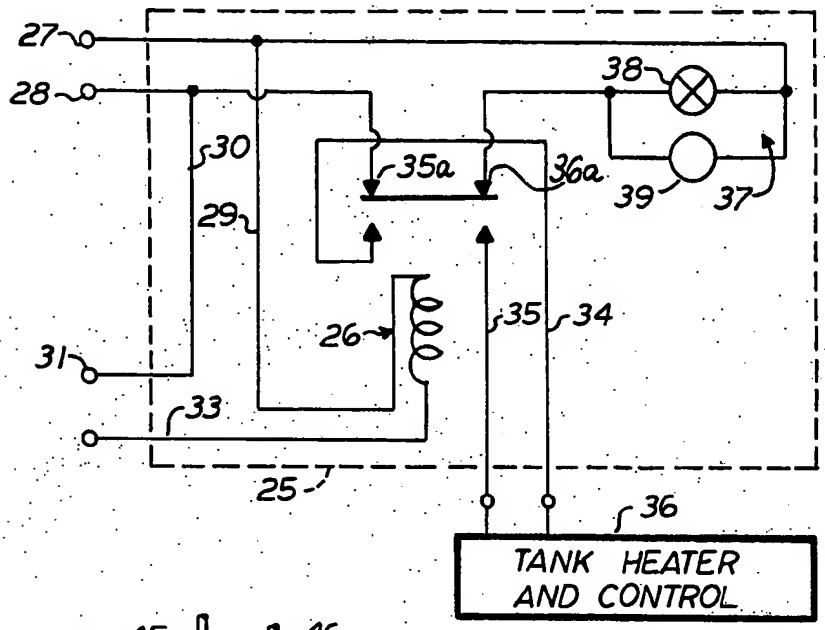

27
28
30
29
31
33
25
26
35
34
35a
36a
38
39
37
36
TANK HEATER
AND CONTROL

FIG. 4

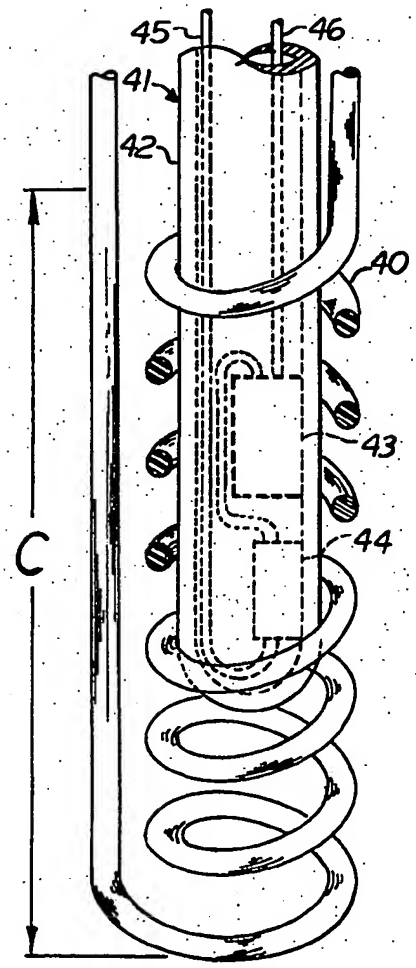

45
46
41
42
40
43
44
C

FIG. 5

LIQUID LEVEL RESPONSIVE CONTROL DEVICE

BACKGROUND OF THE INVENTION

It has long been necessary and desirable to heat various types of liquids in tanks, as for example liquids used in plating of various kinds as well as in preparing articles for plating and similar processes, the liquids being both acid and alkaline as well as corrosive in many instances.

Inasmuch as such liquids may destroy certain heating elements, such elements must be of composition to resist that action. In acid conditions quartz tube immersion heaters generating infra-red radiation are particularly suitable and well known.

In alkaline conditions, metal tubular heaters for generating radiation are frequently used, though they would be damaged in acid conditions.

In all such instances and environments, the liquid level is necessary to be maintained, as lowering of the level below the upper end of the hot zone of radiating heaters, may result in damage and/or destruction of such heaters, and thus level indicating warning and control systems are particularly desirable.

Such controls have in the past taken the form of float means involving linkages and micro-switches, which are unreliable and adversely affected by the environment.

Other controls known as proximity types have also been used, but these involve delicate parts and circuitry including capacitors which may be initially workable but do not stand up under the conditions to which they are subjected, and are thus affected as to accuracy and reliability.

Thus the instant invention, which embodies an entirely new approach, is particularly suitable since the parts may be of rugged construction and in any event are not subject to many of the problems of prior liquid level responsive control means, being simple in construction and operation with fail safe means to provide maximum effectiveness and instant response.

With the foregoing in mind, the principal and other objects and improvements of this invention will be understood from the description and claims appended hereto and shown in the drawing wherein:

FIG. 1 is a vertical sectional view, partly fragmentary showing one form of heater device used in the control means hereof.

FIG. 2 is an enlarged fragmentary view of the lower end of the sensing instrumentalities.

FIG. 3 is a cross-sectional view taken about on the line 3—3 of FIG. 1 looking in the direction of the arrows.

FIG. 4 is a diagramatic view showing the circuitry which is suitable for use herein.

FIG. 5 is a fragmentary view, in elevation, side elevation, showing another form of heater used in this concept.

DESCRIPTION OF THE INVENTION

Referring to the drawing, there is disclosed a liquid level responsive control means which embodies basically an immersion heater of the quartz tube type generally denoted 1, which includes a body of quartz 2 having the lower end sealed at 3 and incorporating therewithin the heating means 4 which includes a suitable support 5 of tubular nature around which is positioned a suitable resistance wire of nichrome or the like designated 6 in the form of a coil which is in turn coiled on the member 5 and as such provides a hot zone indicated at A extending from the line 7 to the lower end at 8 and a cold zone B extending from the line 7 upwardly to the line indicated at 9 as a basis for definition.

The heater just described is generally conventional in form and quartz is used for the body 2 because it is transparent to radiation and thus is particularly suitable for use in the conditions to be subsequently setforth.

The heater as usual includes a cover at 10 within which the usual connecting means such as 11 are provided leading to a conductor cable 12 with the conductors 13 and 14 extending outwardly therefrom for connection in a manner to be setforth.

Along side the body 2, in contact therewith and thus having line contact, is a further tube of quartz indicated at 15, likewise sealed at 16 at its lower end, this tube being designated as embodying the sensing instrumentalities hereof.

Within the tube 15, there is provided, a non-recycling fuse 17, having the leads 18 and 19 extending therefrom, reference being had at this point to FIG. 2, those leads extending upwardly and being of such a nature that with the insulation thereon a spring-like condition is provided to maintain the fuse 17 in position against the wall of the tube 15.

Above the fuse 17 is a recycling switch such as of bi-metal construction designated 20, which is connected to the fuse 17 so that the fuse 17 is in series therewith from the lead 21 extending from said switch 20 and a further lead 22 is provided extending upwardly and indicated as leading outwardly from the cover 10 in FIG. 1.

It is again noted that with the insulation and spring-like nature of the wires forming the lead, the switch 20 and fuse 17 are maintained in their lower positions at the lower end of the tube 15 being the sensing instrumentalities as heretofore stated.

The sensing instrumentalities just described, are positioned so that the fuse 17 and switch 20, are at the central portion of the hot zone A as noted in FIG. 1, and thus when the radiation is being developed by the heater element 6, the infra-red nature thereof will cause the same to pass through the body 2 being transparent to infra-red radiation at the short wave length end of the spectrum, specifically at wave lengths on the order of 3 to 4 microns and likewise penetrate the tube 15 which is also of quartz and thus transparent to such radiation.

However since in the ordinary use of this particular device, while not intended as a means to provide heat to the solution is primarily directed to controlling the operation of other heaters therein, and thus is normally immersed in the solution to some point such as is suggested at and by the line 23.

It will thus be seen that normally the radiation produced by the element 6, is not direct radiation to the switch 20 and fuse 17 but is absorbed largely by the fluid in which the device just described is immersed and operates therefor as a heater.

It is proposed that the heater in this instance be one of about 1,000 Watts and thus is denominated as a de-rated heater.

In order to control the heater just heretofore described, the control circuitry is enclosed in a box designated diagramatically at 25, and taken with the sensing instrumentalities previously just described, is consid-

ered to be the control unit hereof and as such will be described with that in mind.

Within the housing or box 25 a suitable switch 26 is provided, being of the normally open type, which supplied with energy from a 110 Volt line and leads 27 and 28.

The leads or conductors 27 and 28 in turn provide for energizing the switch 26 by means of further leads 29 and 30 through the connection thereof at 31 with the lead 22 of the sensing instrumentalities which will for the sake of this description here be designated as 32, the other lead from the switch 26 being designated 33 and connected to the lead 18 from the sensing instrumentalities 32.

It will thus be understood that when the switch 26 is energized by application of power through the leads 27 and 28 from any suitable source of power, the switch will close and complete the circuit, through the switch 20 and fuse 17, the same time directing power or controlling the power to the tank heaters through the leads 34 and 35, the tank heater being indicated at 36 as a single unit but obviously being arranged so that the heat may be applied to the tank in any preferred form as by a series of immersion heaters all of which are controlled by the tank heater arrangement and thus operable when it is operating.

Assuming that the conditions are as shown in the drawing, it will be seen that with the level of the liquid at 23, the heater 4 and its associated sensing instrumentalities are immersed in the liquid to a point where the normal heating action of the heater is taking place, but if the liquid level drops for any reason whatsoever to a point where the switch 20 is exposed to direct radiation from the heating coil 6, without the surrounding fluid, that direct radiation will cause a 1,000° F. or more immediate increase in temperature effecting a very positive actuation of the switch 20, being bi-metallic for example, so that it will open.

Immediately upon the opening of the switch 20, the circuit through the leads 18 and 22 and thus 31 and 33 into the control housing 25, will interrupt the actuation of the switch 26 permitting the switch to open, and thus completing another circuit therewithin including the contact 35 and a contact 36 therein the switch likewise, which in turn will operate to provide a signal from a signaling source 37 which may include a horn such as indicated at 38 and a light 39 either or both of which may be desirable.

It will be clear that as long as the condition of low level continues, the signal 37 will be actuated, and if the level drops far enough, the direct radiation from the coil 6 will impinge upon the fuse 17, and being non-recyclable, will permanently interrupt the circuit through the entire system.

It should be noted parenthetically that when the switch 26 opened obviously the tank heater and control connected by the leads 34 and 35 was actuated and the heater and control 36 thus operated to interrupt the heating of the tank as well as the operation of the control heater described in detail.

It should be noted that in the event the liquid level does not drop below the area of the switch 20, but in fact is restored to the level 23 for example, without having contacted or permitted direct radiation to contact the fuse 17, the recycling nature of the switch 20 will cause the switch 26 to be actuated again and restore the operation of the tank heater and control as well as the control heater described and indicated in FIG. 1.

The switch 20 is designed to be effective on a large number of recycling actuations and thus observation of the signal will prevent destruction of any article or eliminate the necessity to replace the fuse in the sensing instrumentalities 32.

A modified form of control heater is disclosed in FIG. 5, as embodying tubular metallic heater 40, which in this instance as shown, is arranged in a cylindrical coil, the hot zone being designated C and as indicated also a sensing unit or sensing instrumentalities designated 41 are positioned within the coil to operate in the manner previously described with reference to FIG. 1.

In this instance the sensing instrumentalities are enclosed within a stainless steel tube 42 for example and yet include the recycling switch or bi-metallic switch 43 as well as the fuse 44 connected in series therewith and extending to the leads 45 and 46 comparable to the leads 18 and 22 in the FIG. 1 disclosure.

The lower end of the sensing instrumentalities 41 is positioned so as to be within the central portion of the hot zone C and as such will operate in the same manner as the sensing instrumentalities 32 of FIG. 1.

In this instance however it happens that the sensing instrumentalities in the tube 42 are surrounded by the electric heating element 40 and thus perhaps more instantly affected by direct radiation when the liquid level drops below the upper end of the hot zone and thus direct radiation is effective to operate the switch 43.

Obviously when the fluid level drops if it does so that direct radiation affects the fuse 44, the termination of the heating of the tank may be effected through this control heater just described in the same manner and through the same circuitry as that of FIG. 4. Under certain conditions it may be advisable that fuse 44 have a higher temperature rating than the switch 43 to prevent fuse actuation at the same time as the switch.

In this instance the tubular heater 40, is made of suitable material which will resist alkaline solutions and is of any well known composition, which may be procured from different manufacturers and formed in the manner described.

There is thus provided basically hereby, a means of directing radiation at control or sensing instrumentalities so that other heating means in a tank solution may be controlled, the basic improvement residing in the fact that positive instantaneous control of the heating devices which are used in the tank is effected by a control heater, which in turn depends upon the impact of direct radiation to sensing instrumentalities and controls tank heaters and other means for heating tanks whether of the immersion type or any other means which are suitably to be controlled by this arrangement.

The forms of heaters here described, while having the characteristics of infra-red radiation generating in the 3 to 4 micron wave length area of the infra-red spectrum, are of relatively small size and thus may be classified as control heaters even though they do have the ability to heat small quantities of solutions.

Water based solutions, being capable of nearly totally absorbing such radiation will be particularly suitable for level control indication since an almost instantaneous response of the levels here described to direct radiation will be effected when the solution level drops to a height which will expose either of the recycling switches 20 or 43 or fuses 17 or 44 to direct radiation without the intervening absorptive action of a solution.

The device described, in the forms illustrated are capable of being positioned with the sensing instrumentalities 32 and 41 at different levels in the solution and thus different size tanks may be used and intended changes in solution depth may be accommodated.

I claim:

1. Liquid level responsive control means for use in connection with the heating of liquid in tanks, comprising a control unit, main power supply connections therefore, a source of radiant energy to be immersed in the liquid being heated and connected to said unit to be energized for radiation generation, sensing instrumentalities closely adjacent said source, said instrumentalities including a recycling switch connected to said unit, said switch being operable to terminate operation of the said source, when the switch is subjected to direct radiation from the source aforesaid when the liquid reaches a predetermined lower level.

2. Control means as claimed in claim 1, wherein a non-recycling fuse element is connected in series with the switch first mentioned, to operate when the liquid level reaches a level below that referred to heretofore, and prevent operation of the radiant energy source until said element is replaced.

3. Control means as claimed in claim 2, wherein the source of radiation comprises a quartz tube heater for generation of infra-red radiation, having a hot zone as its lower end portion, the sensing instrumentalities includes a quartz tube in which the switch is positioned above the fuse at the lower end of said tube, said lower end being positioned at the central portion of the hot zone of said heater, and thereby subject to direct radiation when the liquid level is lowered sufficiently to expose at least a portion of said hot zone.

4. Control means as claimed in claim 2, wherein the source of radiation comprises a quartz tube heater body having infra-red radiation generating means therein and having a hot zone at the lower end thereof, the sensing instrumentalities include a quartz tube extending along and in contact with the heater body, said tube having the recycling switch and fuse element therein at the lower end thereof, said lower end being positioned along the central portion of the hot zone of said heater.

5. Control means as claimed in claim 1, wherein the source of radiation includes a cylindrically coiled metal tubular heater for generating radiation, and comprising the hot zone, at the lower end portion of the heater, the sensing instrumentalities comprise a metal tube sealed at its lower end, said fuse element being positioned below the switch therein, and said lower end is located at the central portion of the hot zone aforesaid and within the coils of the heater, being spaced therefrom, whereby when the liquid level reaches a position below the upper end of the hot zone, the switch is exposed to direct radiation and actuates the control unit as stated.

6. Liquid level responsive control means for use in connection with the heating of liquid in tanks, comprising a control unit, main power supply connections therefore, a source of radiant energy to be immersed in the liquid being heated and connected to said unit to be energized for radiation generation, sensing instrumentalities closely adjacent said source, said instrumentalities including a switch connected to said unit, said switch being operable to actuate a signal, when the switch is subjected to direct radiation from the source aforesaid.

7. Liquid level responsive control means for use in connection with the heating of liquid in tanks, comprising a control unit, main power supply connections therefore, a source of radiant energy to be immersed in the liquid being heated and connected to said unit to be energized for radiation generation, sensing instrumentalities closely adjacent said source, said instrumentalities including a switch connected to said unit, said switch being operable to actuate a signal and terminate operation of the said source when the switch is subjected to direct radiation from the source aforesaid when the liquid reaches a predetermined level.

* * * * *